Lesson 5: Topography – Landforms of Parashant

Geological Adventures at Parashant

Exploring the Geology of Grand Canyon-Parashant National Monument

LESSON 5 GUIDE: TOPOGRAPHY – LANDFORMS OF PARASHANT

In Part A, students shape modeling clay into a feature, place it in a transparent container, and add water in increments to make a contour map of the feature. In Part B, they learn how to construct a profile across their contour map. With this concrete, hands-on experience working with maps and profiles, students read about topographic maps and the processes that control the development of landform features, then interpret topographic maps and construct profiles of four different kinds of landscape features at Parashant.

Objectives After constructing a contour map and a topographic profile of a clay model, reading about topographic maps and landscapes at Parashant, and interpreting topographic maps of landscape features at Parashant, students will understand:

- Contour maps and topographic maps are models of the Earth's landscapes
- How to read a topographic map and draw a topographic profile
- How forces and rock materials interact over time to shape the landscape

Concepts Topography, contour interval, contour line, profile, relief, gradient, landscape, landform, controls on landform development, Colorado Plateau.

Duration Three 45-minute class periods

Audience Students in grades 6 to 9

Materials **Part A: Making a Contour Map**

- 12 ounces of modeling clay
- sheet of waxed paper or Styrofoam plate
- clear (transparent) plastic container with clear lid
- metric ruler
- grease pencil or marker
- section of overhead transparency (trimmed to fit lid)
- sheet of white paper
- container of water
- paper towels
- Optional: Colored pencils

Part B: Drawing a Profile

- Contour map (from Part A)
- Thin strip of white paper
- Sheet of graph paper
- Ruler

Elaborate activity (For each pair of students):

- Topographic map and photograph of a Parashant landform (see handouts section)
- Thin strip of white paper (for making profiles)
- Sheet of graph paper
- Magnifying glass
- Optional: Computer to view and magnify pdf's of maps and photographs

Extensions

For all students

- See teacher notes in the **Elaborate** section of the activity for ideas about adapting parts of the activity for various audiences and abilities.
- Provide a local topographic map for students to interpret. Use questions within the activities in this lesson as a guide to making up your own worksheet.

For gifted, honors, or upper level students

- In the **Elaborate** activity, have students do further research to supplement their interpretations of the landform they have been assigned.
- Ask students to plan a hike between points A and B on their topographic map of a Parashant Landform that would be an easier (albeit longer) hike by thinking about gradients along the hike.

Resources

- The USGS guide to topographic map symbols is available at http://erg.usgs.gov/isb/pubs/booklets/symbols/
- TerraServer-USA allows you to access topographic maps as well as aerial photos at http://terraserver-usa.com/
- Michael Ritter of the University of Wisconsin-Stevens Point has made an elegant interactive tutorial about how to draw a topographic profile at http://www.uwsp.edu/geo/faculty/ritter/geog101/textbook/manuals/instructor_manual/how_to/topographic_profile.html

ENGAGE — 10 minutes

Figure 5.1 in the student text shows a contour map of a cinder cone volcano at Parashant. The southeast-trending valley on the feature was most likely the place out of which lava flowed. The cinder cone is elevated about 300 feet above the surrounding landscape. Most students will conclude that the feature is a hill, but their explanations may vary. Some students may have difficulty interpreting the lines on the map. Ask volunteers to share ideas. Accept all reasonable ideas with a simple “thank you” and write them on the board. Avoid providing the “right” answer – students will learn how to interpret contour lines in the lesson.

EXPLORE — 60 minutes

Part A. Making a Contour Map — 30 minutes

In this part of the lesson, students form a landscape feature out of clay and make a contour map of the feature. The purpose of the lesson is to give them concrete hands-on experience that relates 2-D maps to 3-D objects. Try the activity before assigning it to students. This will help you to identify potential challenging aspects and obstacles so that you can provide specific advice in advance.

Most of the **materials** needed for the activity are shown in Figure 1 (next page). To save time, prepare kits in advance for quick distribution.

- Use the modeling clay from Lesson 4. Mix thoroughly to make one uniform color (layers will interfere with the activity).
- Save clear plastic containers from the grocery store – the containers used to hold salads, fruit, etc. work just fine. Containers can be any shape or size as long as they are clean and transparent. The larger the container, the more water you will need.
- A grease pencil or marker (note: using a washable marker would allow for reusing transparencies or tops of containers).
- A small piece of overhead transparency – pre-trimmed to the shape of the top of the container (the top is placed on the container with the piece of transparency on top – see Figure 1).

Figure 1 Materials used in Part A of the lesson. Clay used in earlier lessons has been reshaped into a volcanic cone.

- Sheet of white paper (for students to trace their map onto).
- A metric ruler (to measure elevations on the side of the container).
- Optional: colored pencils or crayons (if you want students to color their contour maps).

Figure 2 Side view of container with model and numbered cm marks.

1. Set up materials in advance for students to save time.

2. Students mark the outside of the container. The zero level need not be marked – this is the level before adding water).

3. Encourage students to make any landform shape they would like. The shapes need to be at least three centimeters high so that there is some difference in elevation. The photo shows a different kind of shape than is shown above. It has a tall volcano and a broad hill.

4. The overhead transparency is used when you have multiple classes. If students were to draw directly on the clear plastic top, the next class needs their own containers.

5. It is important that students look straight down on the model when tracing the outside edge of the clay onto the overhead.

6. Pouring water to the 1-cm mark will make water lap up onto the model. The line formed where the water touches the model creates a line connecting points of equal elevation on the model – a contour line.

7. If students have difficulty seeing where the water touches the clay model, have them shine a flashlight into it, place it on a white sheet of paper, and/or add a drop of food coloring to the water.

8. Figure 3 shows container with water filled to the top of the model, and all contour lines drawn.

Figure 3 Model with contour lines drawn on transparency atop the container.

9. At this point students can put some of their materials away and pour out the water. They now have an overhead transparency with unlabeled lines. Tracing the contour map onto a sheet of white paper (in pencil first) will allow them to begin to label the map with the values of contour lines, to color the map, and to add certain features like scale and contour interval.

10. Write values of contour lines parallel to the lines. On most contour maps, only every fifth line is labeled with a value, but when working with such small models, it is okay to label every line.

11. Figure 4 shows two examples of completed contour maps. The contour interval should be added at the bottom of each map.

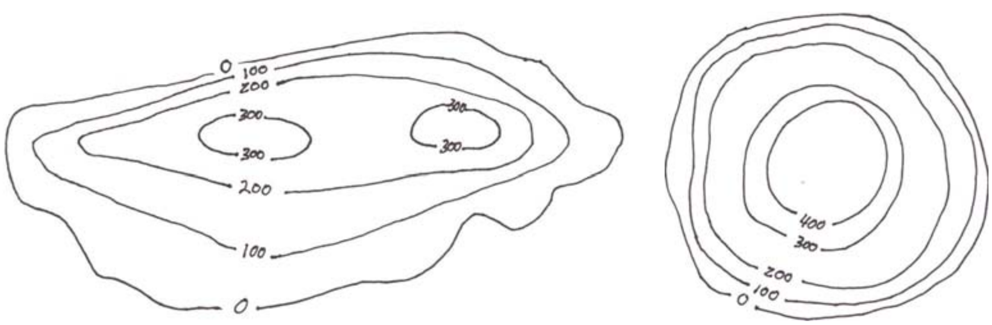


Figure 4 Two examples of contour maps constructed from clay models in water.

12. One aspect of this activity is that contour maps are smaller-scale representations of the real world, but in this case, students produce a scale that is larger than the model.

13. Answers will vary depending on the type of landform feature students modeled. At the very least, they should see that contours form closed loops on hills.

Part B. Drawing a Profile **30 minutes**

In this part of the activity, students construct a profile, that is, a scaled side view of their model. **Materials** needed include the traced contour map, a strip of paper (or a strip of overhead transparency – it allows students to see contour values that might be covered by a paper strip), clear tape, a sheet of graph paper, and a metric ruler.

1. Points A and B should be outside the 0 contour line.

2. The metric ruler is used to draw the line.

3. Taping the ends of the paper down keeps the edge along the line. If students cannot see contour values through the paper strip, that's okay – they can remove the tape in Step 5.

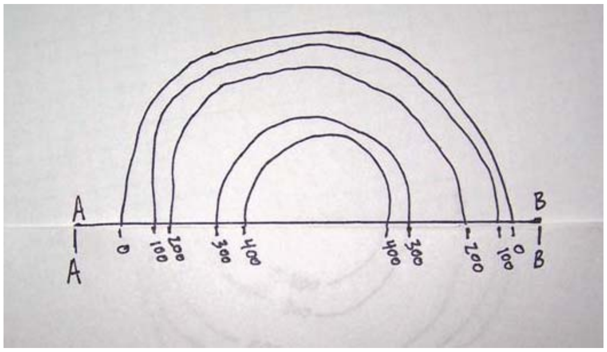


Figure 5 A strip of paper laid along the line that connects points A and B is marked with elevations from the contour map. The strip is used to make a profile (see Figure 6).

4. In this step, students mark the locations of end points of the profile and the points at which contour lines intersect their paper strip.

5. Students should write down the values as shown in Figure 5 above.

6. Taping the strip of paper to a line along the bottom of the graph paper will make it easier for students to transfer the data to the profile (see Figure 6).

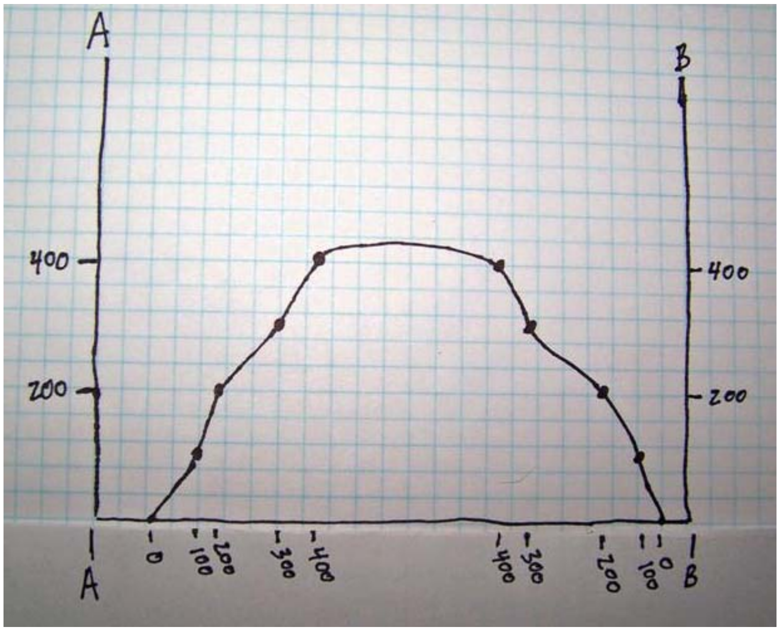


Figure 6 Tape the paper strip with contour values to graph paper as shown. With a ruler, draw a horizontal line between points A and B and then the two vertical axes. Transfer the contour values to the graph paper as dots. Finally, connect the dots with a smooth line.

7. Assume that the horizontal scale of your contour map is 1 cm = 100 m. This means that every one inch on the map is 100 meters on Earth. At points A and B, draw vertical lines upward. Number them to make your vertical scale. Let each centimeter equal 100 meters.

8. Directly above each tic mark on your paper strip, make a small dot on the graph paper at that elevation. Make a small dot for each tic mark on your paper.

9. When you have placed all the elevation dots on the graph paper, connect them with a smooth line. You now have a profile.

EXPLAIN

Assign for reading during class or as homework (even if the activity has not yet been completed). You can supplement the explanation phase of the lesson with a discussion or lecture. Photographs of landforms and a map of landscape regions of the US would be most relevant to the lesson. See the resources section of this guide for web sites that provide photographs that you can use. Photographs of local or regional landforms would increase the relevance to students.

ELABORATE **50 minutes**

In this activity, students interpret a topographic map and a photograph of a landform at Parashant. They should consider the reading and make careful observations of the photograph to hypothesize about how the landscape formed. This activity should be done in pairs (not large groups), with each pair getting a map and photograph. This will allow for multiple interpretations of question 4, which creates a more lively discussion. Note that we refer in the lesson to Grand Canyon-Parashant National Monument as “Parashant” throughout the lesson. One of the landscape features students will study in this section is Parashant Canyon, and we refer to it as such to distinguish it from Parashant the monument.

Keep in mind that this is an interpretation activity. Students will learn more about interpreting landforms after they have completed Lesson 6. Decide how far you think your students can take things (without being frustrated) and what you think they are capable of accomplishing. Above all, remind them that the activity gives them a chance to apply what they have learned and to pose questions and use you as a resource.

Question 4 will be the most challenging. Encourage students to take risks and remind them that it is okay to speculate here. Their responses, questions, and comments should provide rich information that you can use to assess what they learned from the reading, as well as well as their ability to make observations and inferences. If you think that question 4 is too challenging for students, you can wait until students have completed Lesson 6 to assign it, or you can project the maps and photographs with a computer and turn this into a class discussion activity, taking students through the landforms step-by-step.

The **materials** you will need include laminated color copies of the topographic maps and photographs, rulers, small strips of paper and graph paper (for making the profiles), and a magnifying glass (to view maps and photos more easily). As an option, provide the files for the maps and photographs to students to view on a computer so that they can magnify the images (or project them inn the classroom so that students can zoom in when things become difficult to see).

Responses to the questions for each of the four maps and photographs are provided on the following pages.

Map A – Little Springs

2.

a. The contour interval of the map is 40 feet

b. The highest elevation on the map is 7015 feet (marked with an X in the upper left)

c. The lowest elevation on the map is 6120 feet (lower right).

d. The total relief of the map is equal to 7015 feet – 6120 feet = 895 feet.

e. The main type of landform shown on the map is a cinder cone (at least six are visible).

f. Students might note that there is a valley in which there is a lava flow and a wash.

3. For the profile of Little Springs, have students use a vertical scale of one inch = 400 feet, labeling the bottom of the Y axis with 6000 feet and the top of the Y axis 7200 feet. The elevation at point A is 6840 feet, and the elevation of point B is 6220 feet.

4. Answers will vary, but students should refer to eruption of cinders (to form the cinder cones shown in the photograph and the cinder cone shown on the topographic map) and the eruption of lava (shown on both the photograph and topographic map).

Map B – Grand Wash Cliffs

2.

a. The contour interval of the map is 40 feet

b. The highest elevation on the map is 6428 feet (marked with a triangle at Blanco in the upper center part of the map)

c. The lowest elevation on the map is 4480 feet (in the intermittent stream in the lower left, due west of the 4600 foot contour value).

d. The total relief of the map is equal to 6428 feet – 4480 feet = 1948 feet.

e. The main type of landform shown on the map is a cliff.

f. Students might note that there are mountain peaks, buttes, and/or washes.

3. For the profile of Grand Wash Cliffs, have students use a vertical scale of one inch = 500 feet, labeling the bottom of the Y axis with 4500 feet and the top of the Y axis 6500 feet (this makes the profile just under four inches tall). The elevation at point A is 4550 feet, and the elevation of point B is 6000 feet. One tricky aspect to this profile is the vertical cliff on the right side of the profile. Look closely at the contour lines above the 5600 foot contour line ½ inch north of the profile, and you will see the 5800 and 6000 foot contours merge into one. This means that where the profile crosses the 5800 foot contour, it also crosses the 6000 foot contour due to a vertical face.

4. Answers will vary, but students should refer to faulting and uplift (raising the land on one side of the fault and lowering the land on the other side to create a difference in elevation), weathering and erosion of sedimentary rock (seen as layers in the photo, and which falls down the slope), differences in weathering of the rock layers (creating some layers with cliffs/steep slopes and some layers with more gentle slopes).

Map C – Shivwits Plateau

The part of the Shivwits Plateau shown here is just north of the boundary between Parashant and Grand Canyon National Park. The line of the profile runs across the mesa from left to right (the right side of the mesa is in shadow in the photograph).

2.

a. The contour interval of the map is 40 feet

b. The highest elevation on the map is 6520 feet at the bottom center part of the map (three contour lines above the marked 6400 foot contour interval).

c. The lowest elevation on the map is 4320 feet in the upper left corner, two contours below the marked 4600 foot contour interval.

d. The total relief of the map is equal to 6520 feet – 4320 feet = 2200 feet.

e. The main type of landform shown on the map is a mesa.

f. Students might note that there are cliffs on each side of the map, and a few buttes.

3. For the profile of Shivwits, have students use a vertical scale of one inch = 500 feet, labeling the bottom of the Y axis with 5000 feet and the top of the Y axis at 6500 feet. The elevation at point A is 5200 feet, and the elevation of point B is 5400 feet. Note that the 6120 contour interval crosses the profile multiple times along the top of the plateau.

Students can draw a fairly flat mesa top on the left side of the profile. The highest point on the profile appears to be about 6140 feet, which is between two contour lines.

4. Answers will vary, but expect students to refer to uplift of the land (to create differences in elevation), weathering and erosion of rock (to sculpt the cliffs and slopes of the mesa).

Map D – Parashant Canyon

2.

a. The contour interval of the map is 40 feet

b. The highest elevation on the map is about 5523 feet (marked with an X atop a small hill visible in the lower right corner of the map).

c. The lowest elevation on the map is 4360 feet, the last contour line visible in the canyon on the lower right side of the map (the wash crosses the 4360 contour about one inch below the “P” in “PARAS” and is somewhat obscured by the vertical red section line)

d. The total relief of the map is equal to 5523 feet – 4360 feet = 1163 feet.

e. The main type of landform shown on the map is a canyon (a number of side canyons are visible).

f. Students might note that there are a number of buttes, cliffs, and several washes.

3. For the profile of Parashant Canyon, have students use a vertical scale of one inch = 500 feet, labeling the bottom of the Y axis with 4000 feet and the top of the Y axis 5500 feet. The elevation at point A is 5440 feet, and the elevation of point B is 6220 feet. Note that the gradient is very steep near the bottom of the canyon – the 4600 and 4800 contours are very closely spaced, forming near vertical cliffs on either side of the canyon. The mirror image of cliffs on opposite sides of the canyon is mainly due to the presence of the same cliff-forming and slope-forming rock units on either side of the canyon.

4. Answers will vary, but expect students to refer to the importance of weathering and erosion to change the rock layers. Loosen the material, and carve the canyon. Students might also refer to the role of uplift in creating differences in elevation.

EVALUATE

1. The following questions relate to the topographic map shown in Figure 5.7.

a. The wash runs south to southwest

b. The highest elevation shown is 5520 feet

c. The lowest elevation on the map is 4400 feet.

d. The total relief of the map is 5520 feet minus 4400 feet, or 1120 feet.

e. The lower left corner of the map has the steepest gradient because contours are most closely spaced together there.

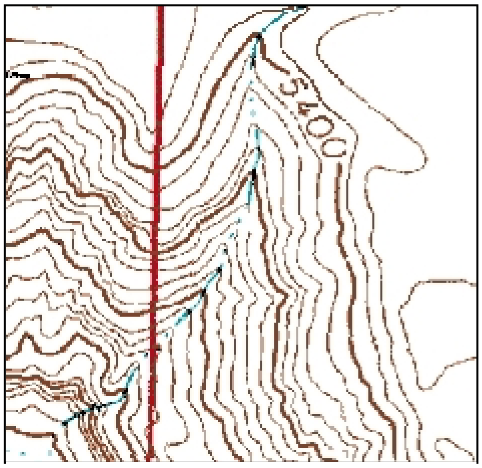


FIGURE 5.7. Part of a topographic map at Parashant. The contour interval is 40 feet. North is towards the top.

2. Relief is important in landform development because the greater the relief, the greater the forces that work to change the landscape. For example, water flows more quickly in areas of high relief, causing faster erosion. Rocks that tumble down slopes have more energy.

3. The arid climate of the Colorado Plateau affects the creation of its landforms because it affects the number of plants on the ground (which act to hold soil and sediment in place, slowing erosion) and also leads to flash floods associated with thunderstorms in the monsoon season.

4. Earth’s inner heat has played a role in shaping the landscape at Parashant by 1) causing volcanoes, which build up the land surface, and 2) causing uplift of rock layers to form cliffs and greater relief in general.

WORKSHEET 5.1 – PARASHANT LANDFORMS

Photos for Map A - Little Springs Area Cinder Cones

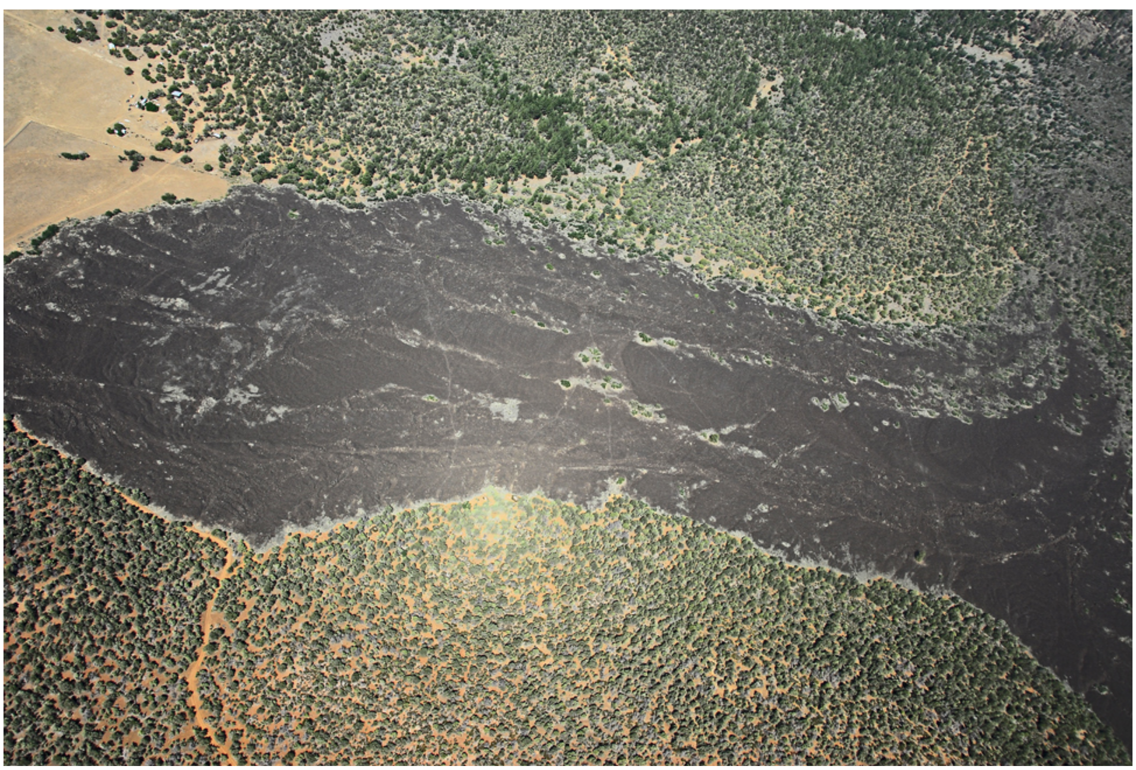
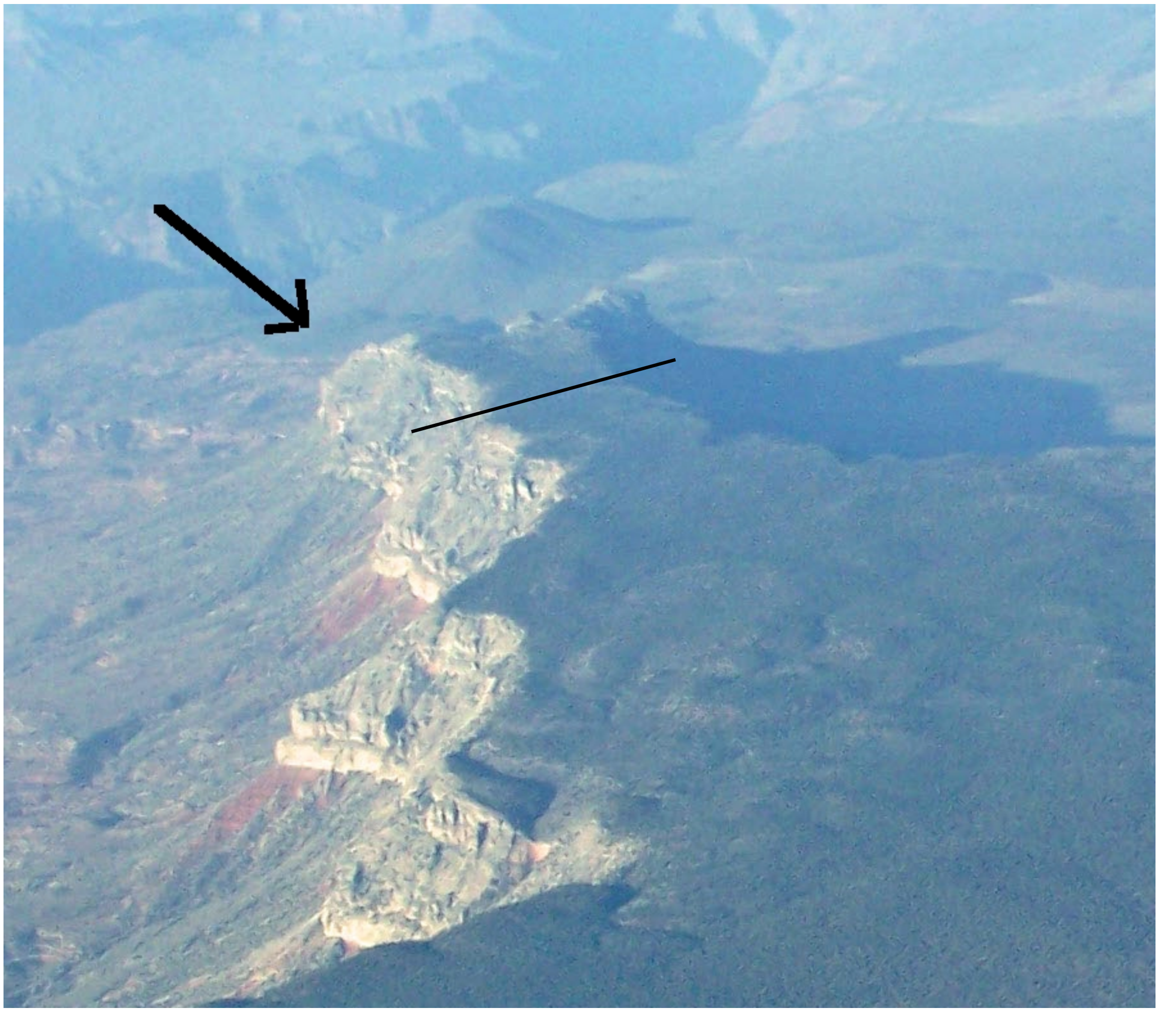


Photo for Map B - Grand Wash Cliffs

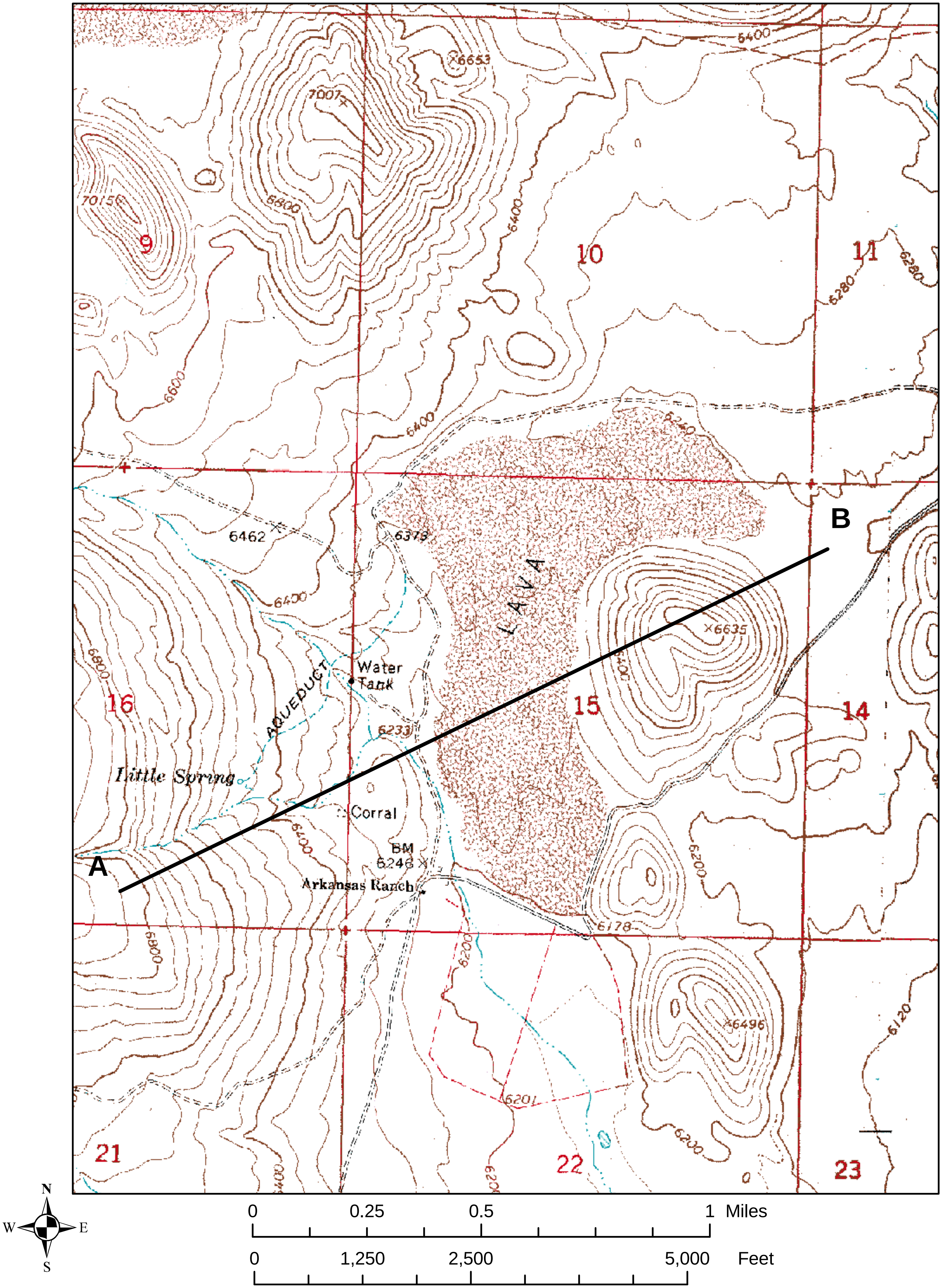
Photo for Map C – Shivwits Plateau



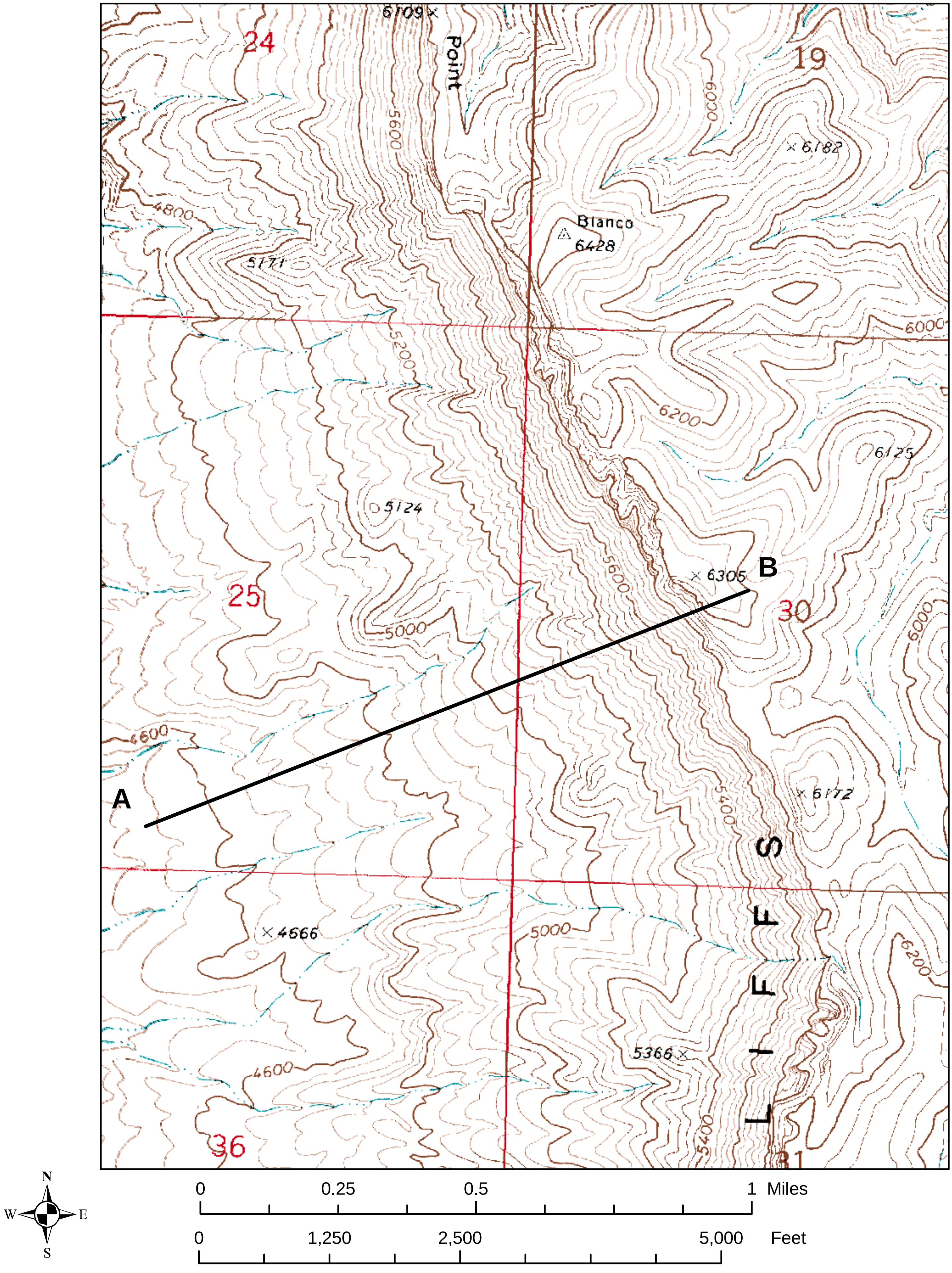
The arrow shows the feature in the topographic map. The line shows the location and orientation of the profile.

Photo for Map D - Parashant Canyon

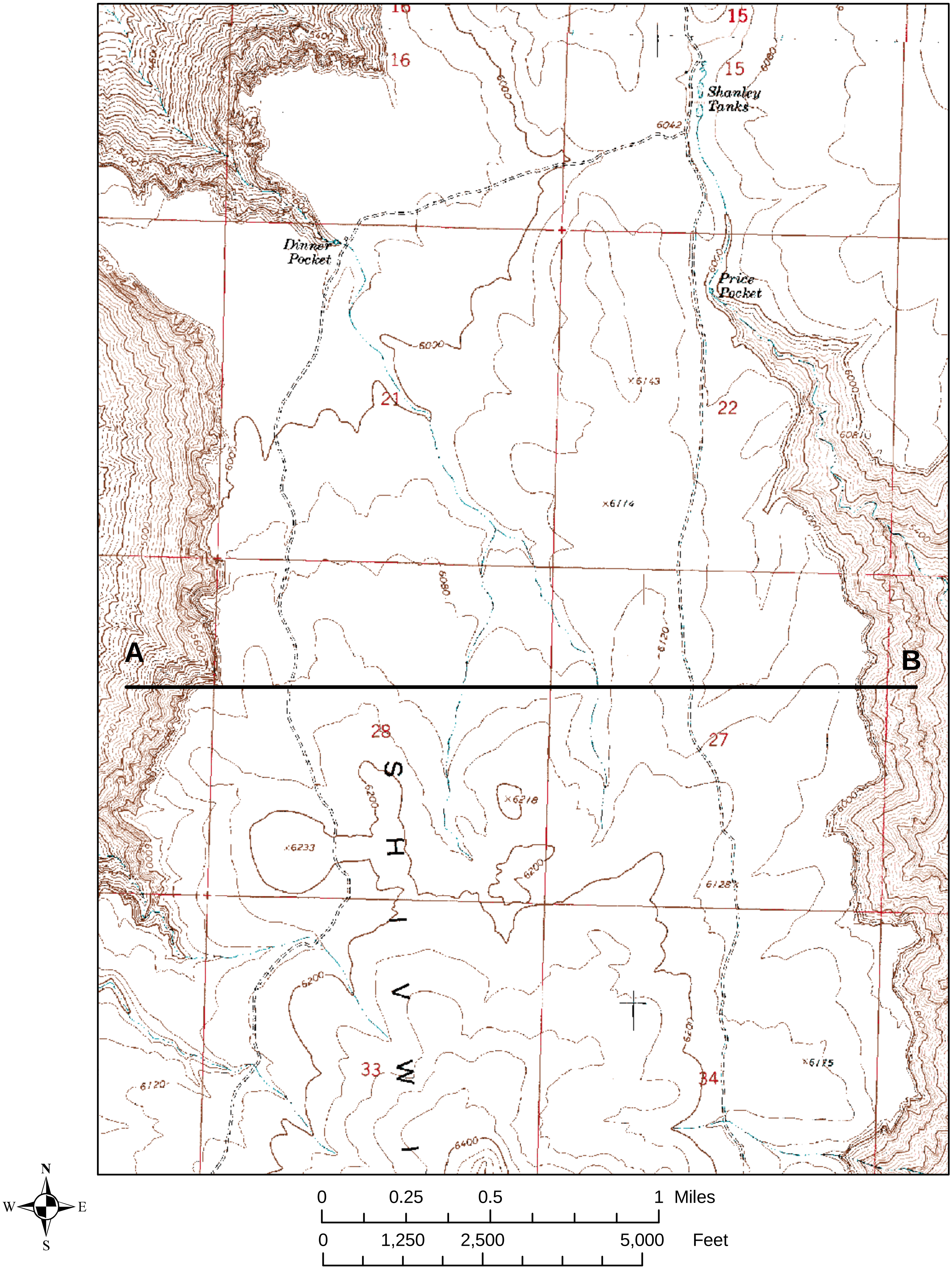
Map A - Little Springs



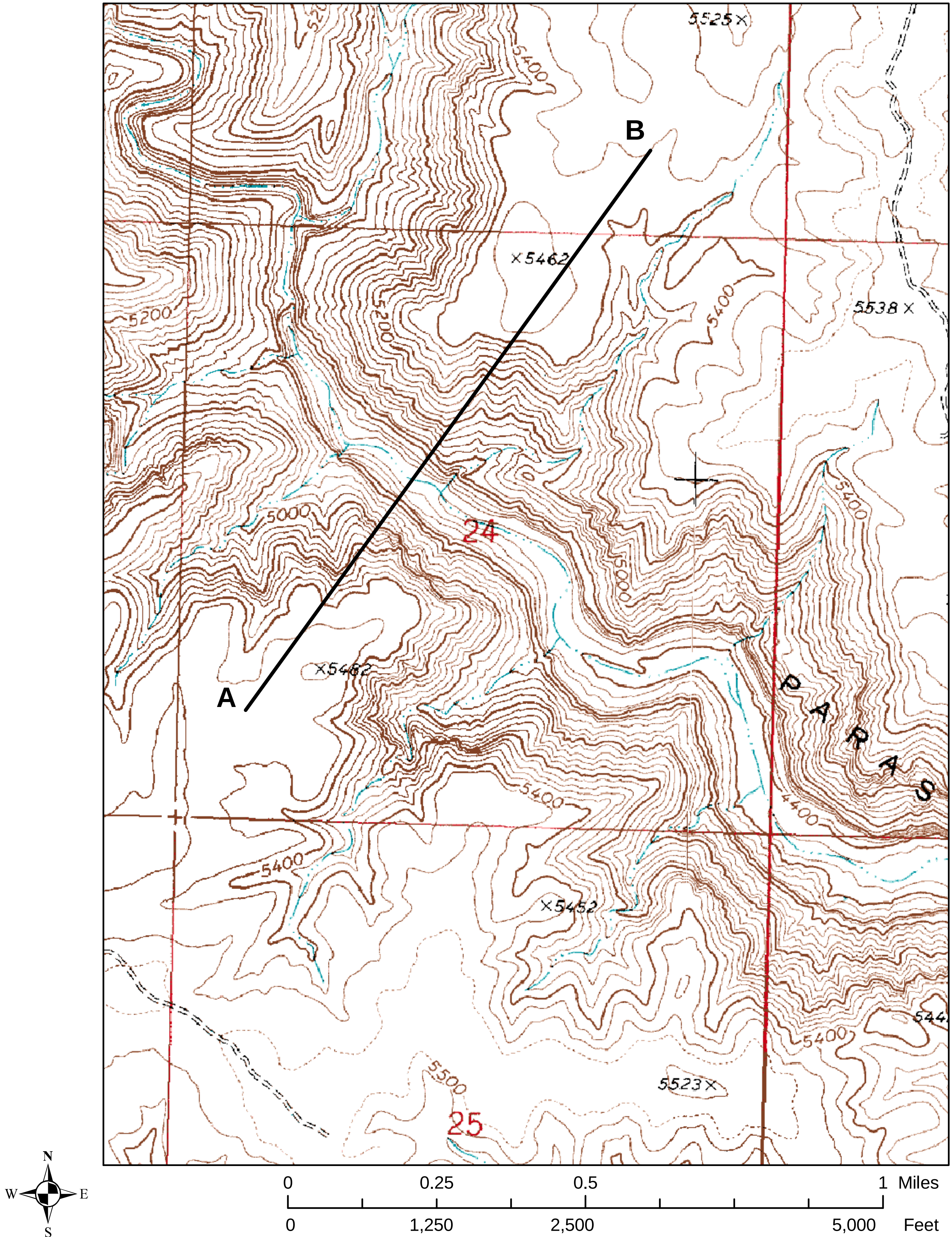
Map B - Grand Wash Cliffs



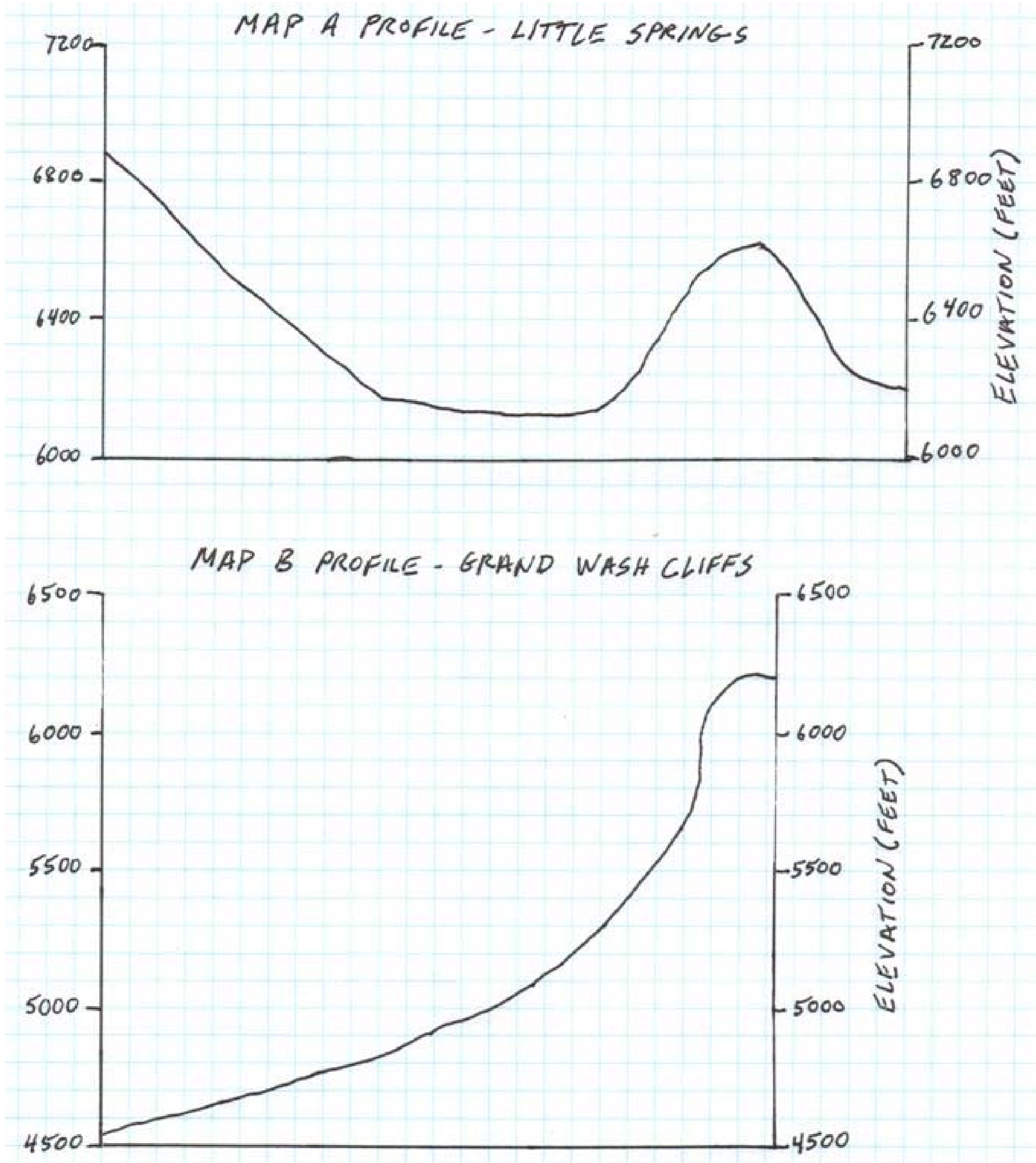
Map C - Shivwits Plateau



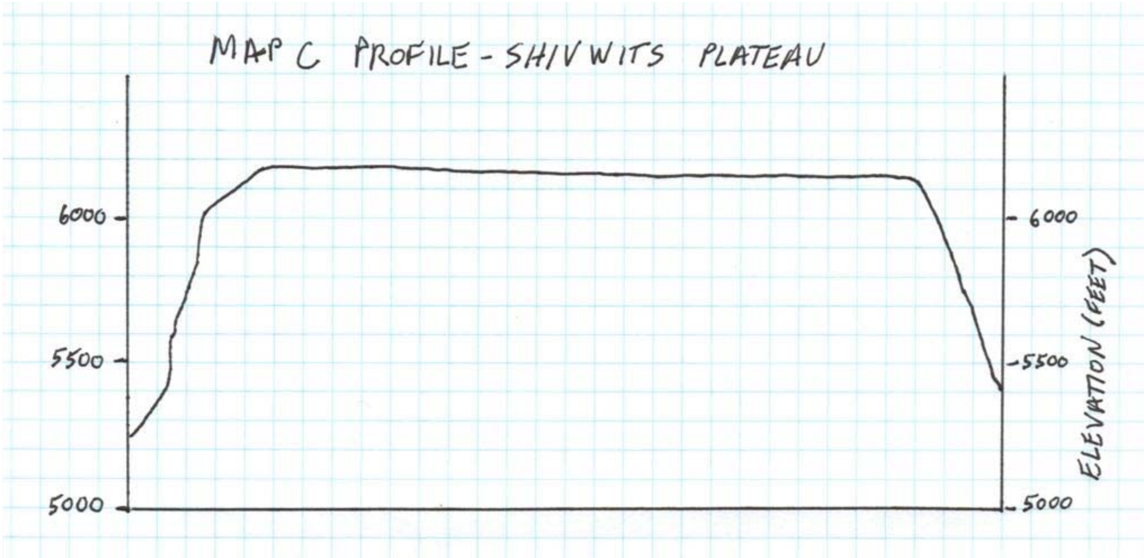
Map D - Parashant Canyon

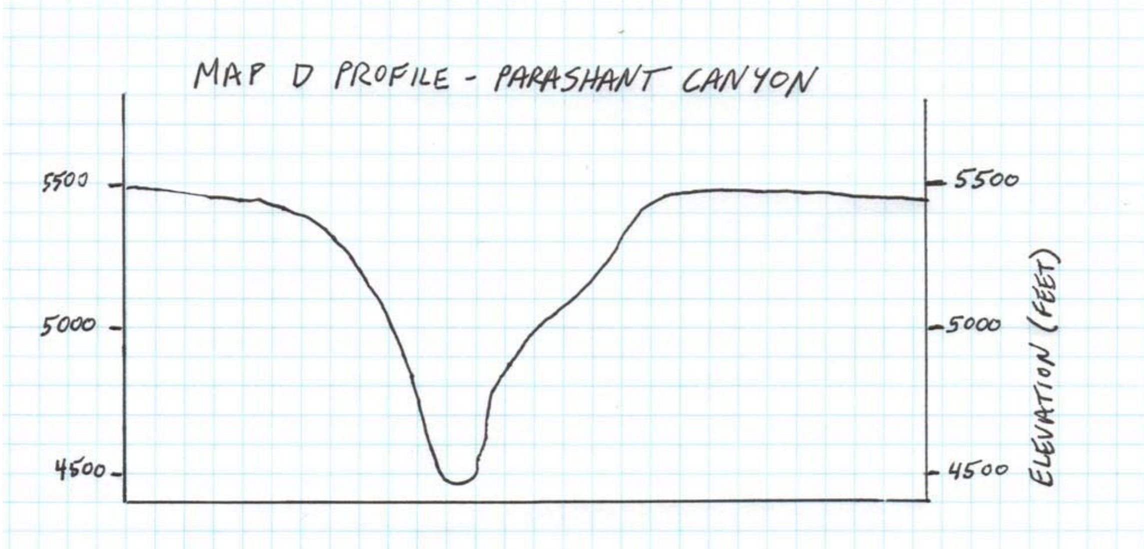


Profiles for Map A (Little Springs) and Map B (Grand Wash Cliffs)



Profiles for Map C (Shivwits Plateau) and Map D (Parashant Canyon)





LESSON 5: TOPOGRAPHY – LANDFORMS OF PARASHANT

ENGAGE

Look at Figure 5.1. What kind of landscape feature do you think the map shows: a hill, a cliff, a depression, or a flat plain? Explain your reasoning.

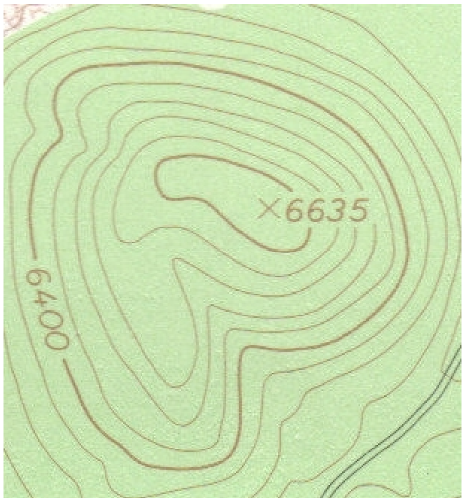


FIGURE 5.1. Map of a landscape feature at Parashant. Numbers are feet above sea level.

EXPLORE

Part A. Making a Contour Map

1. From your teacher, obtain 12 ounces of modeling clay, a clear plastic container with clear top, a piece of overhead transparency, a grease pencil or nonpermanent marker, a container of water, and a metric ruler.
2. Using the metric ruler, make a mark every one centimeter on the outside of the container from the bottom to the top. Number the lines starting with 1.
3. Form a mountain, volcano, or other landscape feature out of the modeling clay. Place it in the container, as shown in Figure 5.2.
4. Tape the overhead transparency to the top with two small pieces of tape. Put the top on the container.
5. Looking straight down on the model, trace the outside edge of the clay onto the overhead.
6. Pour water into the container until it reaches the 1 cm mark.
7. Place the top on the container, and trace the line made by the water where it laps up onto the clay. This new line will be inside the first one.
8. Keep adding water and tracing the lines until water reaches the top of your model.

FIGURE 5.2 Clay model of a volcano in a transparent container.

9. Remove the transparency. Place it between two sheets of white paper, and trace the map in pencil on the top sheet of paper. You are now ready to label your map with lines of equal elevation, or **contour lines**.

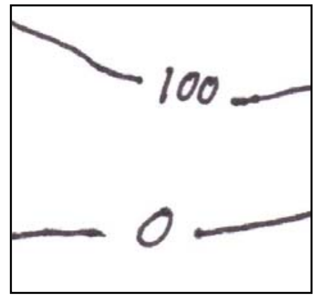


FIGURE 5.3 Write values for contour lines parallel to the lines.

10. Let each centimeter on the model represent 100 meters difference in elevation. Label the outside line "0" by erasing part of the line and writing a zero as shown in Figure 5.3.

11. Label every line (0, 100, 200) until you have labeled every 100 meters on your model.

12. Add a legend. Write "contour interval 100 meters" and "Scale: 1 cm = 100 m" at the bottom of the map.

13. Compare your contour map to the contour map shown at the start of this lesson. Describe the similarities and differences.

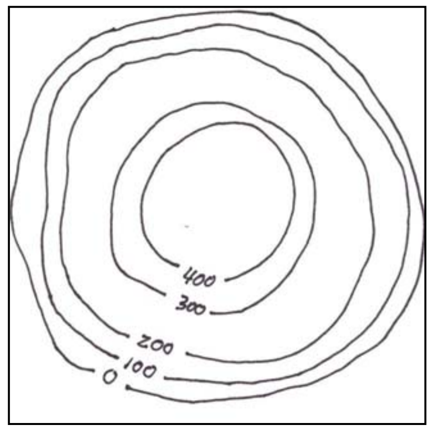


FIGURE 5.4 Sample contour map.

Part B. Drawing a Profile

In this part of the activity, you will draw a side view of your model, called a profile.

1. Pick two points on opposite sides of your contour map. Label them A and B

2. With a ruler and pencil, draw a light, straight line connecting the two points.

3. Lay the edge of a strip of paper along the line you have drawn. Tape the ends of the paper down to keep the edge along the line.

4. Make tic marks at points A and B, and wherever the edge crosses a contour line.

5. Label points A, B, and the other tic marks with the values (see Figure 5.5).

6. Remove the strip of paper and tape it along a line the bottom of a piece of graph paper.

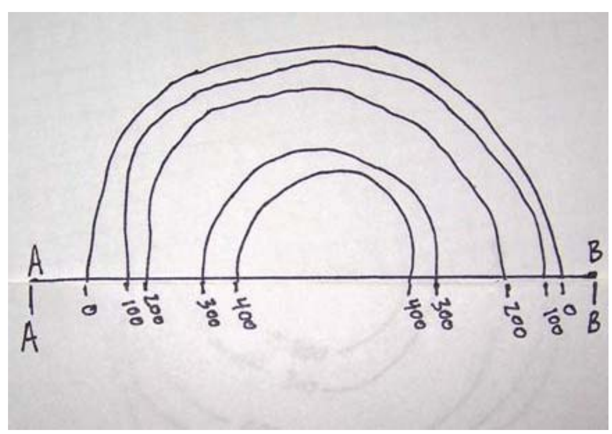


FIGURE 5.5. Tape a strip of paper to your contour map as shown. Mark the locations of A and B on the strip. Then mark and write down the value of each contour line that crosses the strip.

7. Assume that the horizontal scale of your contour map is 1 cm = 100 meters. This means that every one centimeter on the map is 100 meters on Earth. Using a ruler at points A and B, draw vertical lines upward. Number them to make your vertical scale. Let each cm equal 100 meters.
8. Directly above each tic mark on your paper strip, make a small dot on the graph paper at that elevation. Make a small dot for each tic mark on your paper.
9. When you have placed all the elevation dots on the graph paper, connect them with a smooth line. You now have a profile.

EXPLAIN

Contour maps like one you made of a clay model provide information about the shape of the land. The **contour interval** of the map tells the difference in elevation between two adjacent lines. If the contour interval is 100 feet, then adjacent lines will have elevations of 100 feet, 200 feet, and so on. On most contour maps, only every fifth line is labeled with an elevation. These lines are usually thicker and serve as reference points. If the contour interval is 40 feet, then every 200 feet will be labeled (5 X 40).

The highs and lows of the land surface are known as **relief**. Total relief is found by subtracting the lowest elevation from the highest elevation. The total relief of the map shown in Figure 5.5 is 400 meters. The greater the total relief on a map, the greater the contour interval is. The **scale** relates the distance on the map to the distance on the ground. You can use the scale to measure distance between points or estimate the area that a feature covers.

Topography refers to the shape of the land. A **topographic map** is a special kind of contour map. In addition to contour lines, it shows roads, trails, place names, rivers, lakes, buildings, vegetation, and more. The United States Geological Survey (USGS) has prepared topographic maps of the entire country. Knowing just a few basic aspects of topographic maps will help you interpret them, plan hikes, and find your way in a state or national park or monument.

One useful feature to understand about topographic maps is the spacing between contour lines. When slopes are steep, contour lines are more closely spaced. On gentle slopes, contour lines are spread farther apart because the elevation changes gradually. To find the **gradient** of a slope, find the change in elevation between two points (elevation of your starting point minus the elevation of your ending point) and divide it by the distance. For example, suppose you plan to hike 4 miles to the top of a hill at a national monument. If the difference in elevation from where you begin to the top of the hill is 800 feet, then the gradient is 800 feet divided by 4 miles, or 200 feet per mile. Contour lines bend into a V-shape in a stream valley, and the V's point upstream. As you saw in Figure 5.1, contour lines form closed loops around the tops of hills, mountains, or depressions (if the values decrease towards the center of the closed loop, it is a depression). Finally, it is helpful to know that every fifth contour line on a topographic map is usually a thicker, darker line with a labeled elevation.

Landforms at Parashant

In order to understand how Parashant's beautiful scenery came to be, we need to define some key terms and identify several factors that control the shape of the land. A **landform** is a recognizable physical feature on the Earth's surface with a characteristic shape that is produced by natural processes. By natural, we mean that mountains, hills, canyons, and valleys, rather than skyscrapers or baseball parks, which are built by people. A large area of land with a distinct set of landforms is called a **landscape**. Examples of landscape regions include mountains, plateaus, and plains.

Three things work together to create a landform – the material (rock or sediment) it is made of, forces that act on those materials, and time. As you learned in Lesson 2, rocks vary in their ability to resist erosion and changes in shape. For example, water and wind move and shape sediment more easily than rock. Some rocks break down to form gentle slopes, while others tend to form cliffs.

Forces that create landforms can be influenced by climate, Earth's internal heat, and relief. Climate controls the vegetation in a region and the types and rates of weathering and erosion of rock. Climate also changes over time, which affects the rate of landform development. The southwestern US has a hot and dry climate, but was much cooler and wetter during recent ice ages.

Earth's internal heat drives volcanism and moves the crust up and down. Relief is very important - the greater the difference in elevation in a region, the easier it is for rock to move downhill and the faster water can flow and carry rock and sediment away. Finally, it takes time for landforms to develop. Some processes act over periods of hours to days (erosion by floods) whereas others may take millions of years (uplifting of Earth's crust).

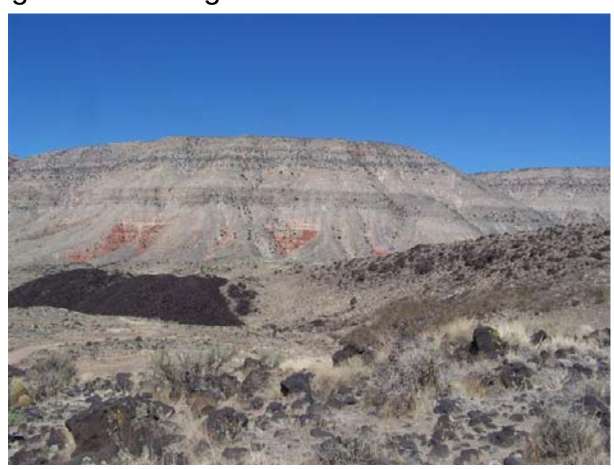


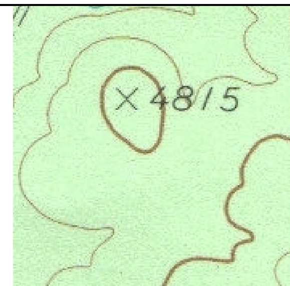
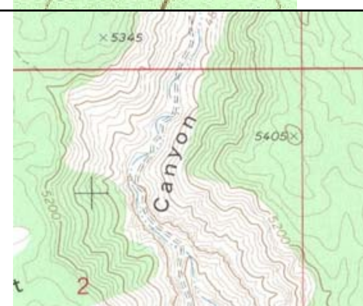
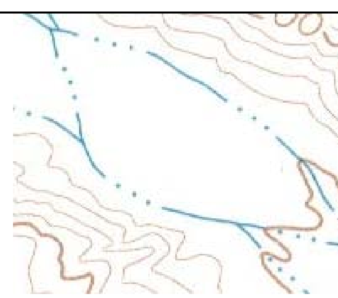
FIGURE 5.6. Earth's internal heat drove two factors that control landform development: the uplift of mountains (background) and the eruption of lava (dark rock in foreground).

Parashant sits on a landscape region that covers parts of four southwestern states called the Colorado Plateau. A **plateau** is a raised landscape confined on one or more sides by a steep boundary. The Colorado Plateau ranges from 4000 to 9000 feet above sea level. It is made up of a series of flat-topped units separated from each other by steep cliffs or steep slopes. Within the plateau are numerous **mesas** (smaller flat-topped mountains that have a steep slope on at least one side), **buttes** (isolated, flat-topped hills with steep slopes), and **pinnacles** (small, slender, pillars of rock).

The western edge of the Colorado Plateau is found in the monument. This western boundary is defined by the Grand Wash Cliffs, which have 2000 feet of elevation change along the Grand Wash Fault (you will learn more about the role of uplift and faulting in shaping the Parashant landscapes in Lesson 6). Rocks are exposed in cliffs and ledges throughout the plateau, which is capped by resistant sedimentary rock units and, in places, topped by volcanoes and lava flows. Two smaller plateaus – the Shivwits and the Uinkaret -- lie upon the Colorado Plateau at Parashant. The Kaibab Limestone caps much of the Shivwits Plateau. The Uinkaret Plateau is dominated by cinder cone volcanoes fed by magma that broke through much older sedimentary rock units within the last nine million years.

Climate helps to shape the landscape of the Colorado Plateau. Much of the Colorado Plateau has an arid climate, which limits the number of plants that grow. Much of the yearly rainfall comes during summer thunderstorms. These heavy rains fill washes (dry channels) with fast-moving water called flash floods. The floods remove sediment not held down by plant roots. This helps to carve spectacular canyons that cut through the raised plateau, exposing thousands of feet of layered geologic strata.

Table 1. Examples of Landscape Features at Parashant.

Description	Photograph	Topographic Map
Cinder cone – Large hill several hundred feet high atop plateaus at Parashant. Formed by the eruption of lava, cinders, and ash. The most recent eruption occurred less than 1000 years ago.		
Butte – A hill that rises abruptly from the surrounding area and which has sloping sides and a flat top. Tops of buttes at Parashant are often capped by resistant sedimentary rock or basalt lava.		
Canyon – Deep gorges that cut into plateaus. Many canyons at Parashant are lined with washes and lead into the Colorado River in the Grand Canyon.		
Cliff – High, steep, overhanging face of rock. The large cliffs at or near Parashant like the Hurricane Cliffs shown here and the Grand Wash Cliffs form along faults. Locally, cliffs are often made of sedimentary rock that is resistant to weathering.		
Wash – The dry bed of a stream that flows only after heavy rains. Often found in the bottom of a canyon. The bottom of a wash is often covered with gravel and sand. Parashant has dozens of washes, but no streams.		

ELABORATE

In this activity, you will interpret a topographic map and a photograph of a landform at Parashant and combine your observations with what you have learned from the reading to speculate about how the landform was made.

1. From your teacher, obtain a topographic map and photograph of a landform at Parashant, a metric ruler, a calculator, a strip of paper, and a sheet of graph paper.

2. Answer the following basic questions about your map.

a. What is the contour interval of the map?

b. What is the highest elevation on the map?

c. What is the lowest elevation on the map?

d. What is the total relief of the map?

e. What is the main type of landform shown on the map?

f. What other types of landforms does the map show, if any?

3. Draw a profile across the map from point A to point B.

4. Study the photograph and the topographic map of your landform carefully. Try to identify some of the processes discussed in the Explain section that might be at work to make this landform. Think about how each of the following might have been involved, then write a few sentences summarizing how you think this landform was made. It is okay to speculate – you will be learning about some of these processes in later lessons, and can come back to revise and improve your interpretation.

a. Weathering – rock being broken down into smaller pieces and sediment.

b. Erosion – removal of rock and sediment by gravity, running water, or wind.

c. Uplift – raising layers of rock upward and causing rocks to break and fracture.

d. Volcanism – erupting lava and cinders to build up the land.

5. Be prepared to present your map and summary in a class discussion.

EVALUATE

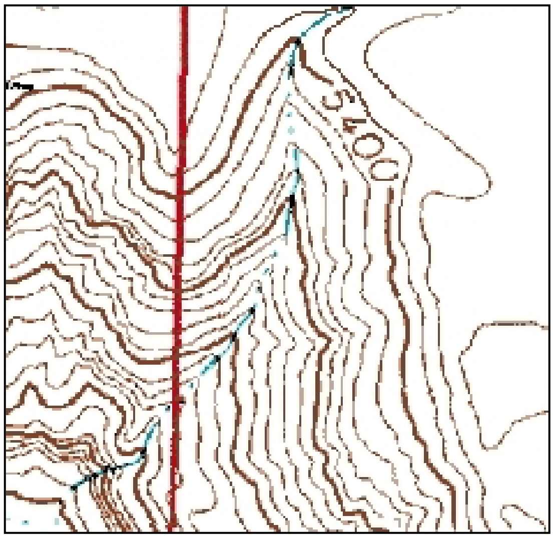


FIGURE 5.7. Part of a topographic map at Parashant. The contour interval is 40 feet. North is towards the top.

1. The following questions relate to the topographic map shown in Figure 5.7.

a. In what direction does the wash (intermittent stream) flow?

b. What is the highest elevation shown?

c. What is the lowest elevation on the map?

d. What is the total relief of the map?

e. Which part of the map has the steepest gradient: the upper right or the lower left? Explain.

2. Why is relief important in landform development?

3. Describe two ways that the arid climate on the Colorado Plateau affects the creation of its landforms.

4. How has Earth's inner heat played a role in shaping the landscape at Parashant National Monument?